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Designing of Cooperative MAC Protocol for Improving the Network Lifetime of MANETs

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***Abstract*— Cooperative communication process the overheard information at the surrounding nodes and retransmission towards the destination to create spatial diversity to obtain higher throughput and reliability To deal with the complicated medium access an efficient Cooperative Medium Access Control (CMAC) protocol is needed. In this paper, we propose a energy-adaptive location-based CMAC protocol, namely DEL-CMAC, for Mobile Ad-hoc NETworks (MANETs). The design objective of DEL-CMAC is to improve the performance of the MANETs in terms of network lifetime and energy efficiency. A utility-based best relay selection strategy is used which selects the best relay based on location information and residual energy. For improving the spatial reuse an network allocation vector setting is used to avoid collision.**

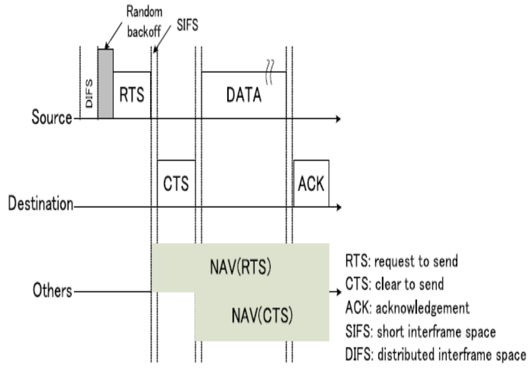
***Index Terms*—Network lifetime, cooperative communication, medium access control protocol, relay selection**

INTRODUCTION

A Mobile Ad hoc network (MANET) is a self configurable network connected by wireless links. This type of network is only suitable for temporary communication links as it is infrastructure-less and there is no centralized control. MANETs Supports anytime and anywhere computing. Mobile terminals such as cell phones, portable gaming devices, personal digital assistants, (PDAs) and tablets all have wireless networking capabilities.

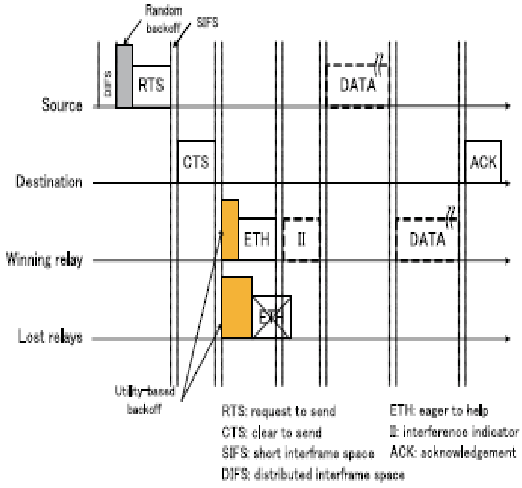
Cooperative communication (CC) is a promising technique for conserving the energy consumption in MANETs. The broadcast nature of the wireless medium (the so-called wireless broadcast advantage) is exploited in cooperative fashion. The wireless transmission between a pair of terminals can be received and processed at other terminals for performance gain, rather than be considered as an interference traditionally. CC can provide gains in terms of the required transmitting power due to the spatial diversity achieved via user cooperation.

Existing System (IEEE 802.11 Protocol)



The IEEE 802.11 protocol uses carrier sense multiple access with collision avoidance (CSMA/CA) as its medium access protocol for the distributed coordination function (DCF) mode. In this mode, each station (STA) can initiate a data transmission by itself. Channel sensing before packet transmission is essential to avoid collisions. If one station has date packet to send, it will first sense the channel to make sure the channel is clear before the actual transmission starts. Since not all stations can hear each other, even if the channel is sensed to be free, a collision may occur. Thus virtual carrier sensing is also employed with the use of the Request To Send (RTS) and Clear To Send (CTS) frames to reserve channel time for the transmitting stations. These two control frames broadcast the channel reservation information to the whole network. Any station will be able to hear at least one of these control packets and use them to calculate the time needed for the data packet transmission. A Network Allocation Vector (NAV) is used by all the stations to discover the time for which the channel is going to be free.

The Proposed DEL-CMAC Protocol



In this section, having the objective of prolonging the network lifetime and increasing the energy efficiency, we design a novel CMAC protocol, namely DEL-CMAC for MANETs. In cooperative communication channel reservation is needed to extend in both space and time To deal with the transmission of packets from control frames RTS, CTS and ACK some additional control frames are required. DEL-CMAC introduces two new control frames to facilitate the cooperation, Eager-To-Help (ETH) and Interference-Indicator (II). The ETH frame is used for selecting the best relay node which is sent by the winning relay to inform the source, destination and lost relays. In this paper, the best relay is defined as the relay that has the maximum residual energy and requires the minimum transmitting power. The II frame is used to reconfirm the interference range of allocated transmitting power at the winning relay, in order to enhance the spatial reuse. We denote the time durations for the transmission of RTS, CTS, ETH, ACK and II frames by T_{RTS}, T_{CTS}, T_{ETH}, T_{ACK} and T_{II}, respectively.

Utility-Based Best Relay Selection

Selecting the best relay node is done based on the location and residual energy information the location information of source and destination is carried by RTS and CTS frames.

The utility backoff timer is given by

$$BUr = \tau \ \min\left(\frac{E}{Er}, \delta\right) * \frac{Pcr}{Pds}/2$$

where Er is the current residual energy of relay r, Pcr is the transmitting power at relay r in cooperative mode, and Pds is the transmitting power at source s in direct mode. The parameters in Eq. (2) include the energy consumption threshold δ, the constant unit time t, and the initial energy E. Intuitively, the terminal with high residual energy and low transmitting power (i.e., small BUr value), has a comparatively short backoff time. The terminal whose backoff expires first will be selected as the winning relay.

RESULT AND ANALYSIS

In this section, we compare proposed system DEL-CMAC with IEEE 802.11 DCF [3]. Since the purpose of our scheme is to prolong the network lifetime and increasing the energy efficiency, the metrics used to evaluation in this paper are total energy consumption, network lifetime and throughput. The transmitting power denotes the power consumed to transmit the packet. The total energy consumption is the sum of the transmitting and receiving energy cost at the source, destination and relay. The lifetime is defined as the duration of the network where the first node dies. To evaluate the performance of DEL-CMAC we compare with IEEE 802.11 DCF protocol. The simulation is carried out in NS2 network simulator. The initial energy of all the terminals is set to 100 J. The simulation settings and parameters are listed in Table 1.

Table 1 : Simulation Parameters

RTS	160 bits	Noise power	-60 dBm
CTS	144 bits	Fixed transmit power	10 dBm
ACK	112 bits	Data rate	1 Mbps
ETH	192 bits	Path lose	3
II	80 bits	Initial energy	100J
PHY header	192 bits	Energy threshold	10
MAC header	272 bits	Power threshold	0 dBm
Unit time	0.1 ms	Circuitry power	7 dBm

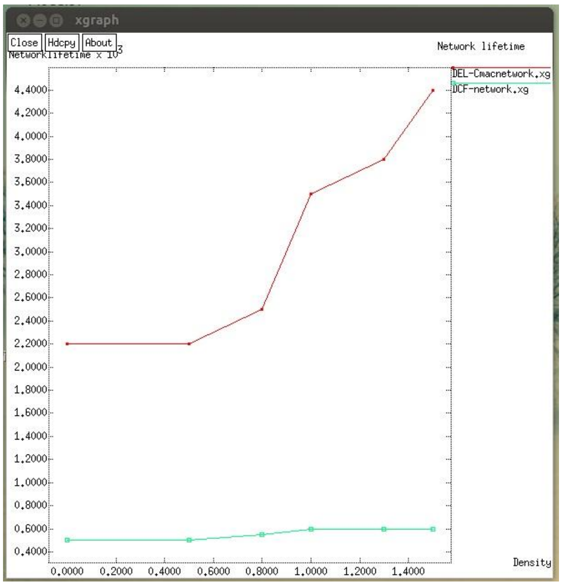


Figure 1 : Network Lifetime

Figure 3 describes the performance graph for network lifetime versus density. Here it is clear that DEL-CMAC is prolonging for more duration as compared to IEEE 802.11 DCF protocol. The performance gain of DEL-CMAC over IEEE 802.11 DCF raise as the number of terminals increases.

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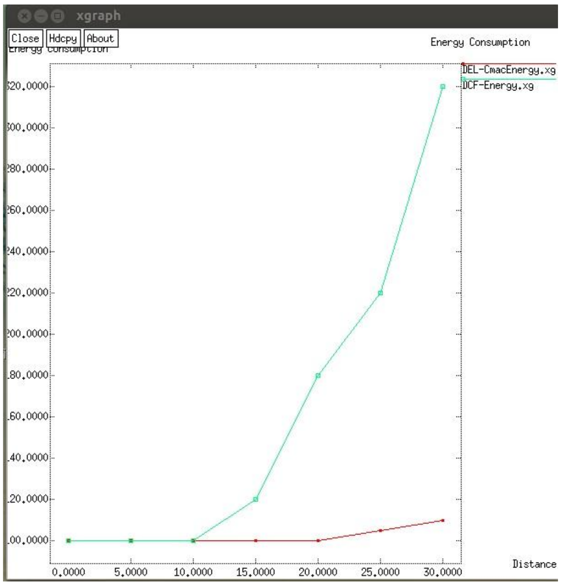

Figure 2 : Energy Consumption

Figure 4 describes the performance graph for energy consumption versus distance. The energy consumption is evaluated from the distance travelled by the node. Here it is clear that DEL-CMAC is using less energy for transmission of data packets as compared to IEEE 802.11 DCF protocol.

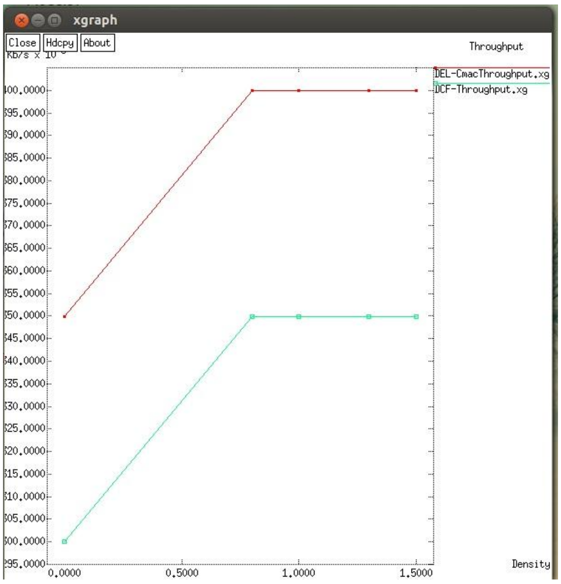

Figure 3 : Throughput

Figure 5 describes the performance graph for throughput versus density. The throughput is evaluated based on the successful transmission of data packet to the destination node by the source node. Here it is clear that DEL-CMAC is having high throughput compared to IEEE 802.11 DCF protocol.

CONCLUSION

In this paper, we have proposed an energy adaptive location-based cooperative MAC protocol for MANETs. In DEL-CMAC we use both energy and location information for improving the network lifetime of MANETs. We have used an effective relay selection strategy to choose the best relay terminal and a power allocation scheme to set the transmitting power. The spatial reuse is enhanced by minimizing the interference by using NAV setting. From the above results we can tell that DEL-CMAC can significantly prolong the network lifetime comparing with the IEEE 802.11 DCF at relatively low throughput and delay degradation cost.

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